Plastics and Microplastics: The OECD's Approach

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1 Introduction

In 2018 the OECD organized the "Global Forum on Environment" on the theme: "Plastics in a Circular Economy - Design of Sustainable Plastics from a Chemical Perspective" with the direction of Working Party on Resource Productivity and Waste [1].

The contents of the Forum, the possible hints and contacts with the research as well as the possible implications with the economy of the participating Countries are still today objects of analysis and debate within the OECD [2–5].

It is in fact since 2015 that the Working Party on Resource Productivity and Waste works on the theme of sustainable plastic materials, after facing a profound examination of plastic pollution starting from the pressing theme of the marine litter and addressing all aspects of sustainability: waste management and circular economy up to the governance of economic systems.

The Working Party has recognized the need to approach the issue of environmental pollution of plastics, from plastic materials and from plastic items, through an optimal management of plastic waste, in a perspective of circular economy and sustainability of the raw materials used, as well as the safety of plastics from a chemical perspective of the additives and reagents used in the plastic cycle.

The effects on ecosystems, with an eco-toxicological approach, have been investigated and scientific evidences confirm the high risk related to the decrease ecosystems' energy and services, as well as the threat to human health that concern microplastics as carriers of microorganisms, even pathogens, and adsorption of POPs [6] which, in reality needs more investigations but for instance must be preserved with a socio-economic and cultural perspective of sustainability and primary prevention.

The Global Forum was used to put under the magnifying glass, the various management examples operating on a local scale in the Forum global context - as is the issue of marine litter - to be able to implement these processes all around the world [1].

M. Cocca et al. (Eds.): ICMPMS 2019, SPWA, pp. 306–313, 2020.
https://doi.org/10.1007/978-3-030-45909-3_49

2 OECD's Approach on Plastic Materials and Microplastics

Since the mid-2010s the OECD Joint Meeting has approached the theme of plastic in the environment and its negative repercussions on ecosystems due to the existence of three concomitant factors:

(1) an ever-increasing use of the very varied applications of polymeric materials in objects of everyday life [7];
(2) the disproportionate increase, both in percentage and absolute weight, of applications for single use products (SUP – Single Use Products) with the concomitant factor of demographic and economic growth in developing countries (from Lower Middle-Income Countries – LMICs to Upper Middle-Income Countries –UMICs);
(3) together with the problem of incorrect management of collection, recycling and product placement of recycled plastics.

From the first approaches to the theme of plastic in the environment, addressing the problem of the Marine litter with the relative macroeconomic framework of this emergency up to the first proposals of economic leverage for containing plastic pollution, the Working Party on Resource Productivity and Waste was one of the most active Working Party on the subject.

The issue of the characterization of plastic pollution is now ubiquitous in the field of scientific literature and of the largest World Organizations (NOAA, UNEP, JRC, GESAMP, etc.) [8], and also the focus of the activities within the OECD - Environment and Health Program - is on the themes disseminated by scientific research, with a land based approach, of an economic, sociological, and technological nature, with a view to making the economic processes of plastics sustainable, in order to ever less impact on the environment. This happens just under the perspective of the OECD mission, through the study and implementation of regulatory actions, on a global scale to mitigate the environmental impacts and on the human health of the family of so-called plastic materials in their use on a global scale.

This work, carried out in concert between the OECD Joint Meeting and various Working Parties, has taken two main strands: the first on the sustainability of plastic materials and their commercial applications and the second on the mitigation of the environmental impacts of microplastics, starting from aquatic systems.

2.1 The Themes of the OECD Global Forum on Environment 2018

The first strand, the sustainability of plastics and its applications in consumer products, was developed and approached with The OECD Global Forum on Environment: "Plastics in a Circular Economy - Design of Sustainable Plastics from a Chemicals Perspective". This Forum was held in Copenhagen, Denmark from the 29th to 31st May, 2018, and hosted by the Danish Government [1].

The idea behind the Global Forum was - and currently implemented within the WPRPW – that of making the supply chain of plastic products sustainable starting from the design of polymeric compounds. The need to improve the sustainability of plastics through chemical re-design [2] and make them more circular as possible when it is feasible to know and select the chemical substances present in mixtures of plastic

materials (polymers and their blends). Exactly these chemicals are those that have certain consequences for the environment and human health, relating the entire life cycle of plastic products up to disposal methods. The "greening design" of plastic materials or the production of plastic items so called "benign by design" [3] are the key step for the realization of the circular economy for plastics. Advancement in the circular plastic economy will allow: better management of plastic waste, recovery of various types of polymers and their reuse in closed chains, with gradually improved environmental management of the products. The releases in the environment of plastics, starting from the infamous disposable products (SUP) will decrease with a clear benefit for human health and the environment, given that widespread losses in the natural environment were creating damage that could not be ignored, instead giving a real signal of reduction of the marine litter starting from land [4]. Very briefly [5] the results of the global forum on what can make the cycle of plastic sustainable in their use are: choice of design goals oriented to the life cycle starting from the selection of raw materials, production and manufacturing, product's use, disposal/recovery plan and options. In addition, for each independent phase of the product's life, it will be necessary make an assessment also giving a benchmark against products that provide the same service realizing a continual improvement of the evaluation, optimization, and design of plastic products.

The existing tools that are available to evaluate the above considerations are risk assessment and life cycle analysis, their outcomes and their continuous implementation make it possible to improve sustainability [3].

The final objectives of this way towards sustainability are: decrease in depletion of natural resources, increased recovery of materials with material recycling policies and re-use of products or their components (Circular Economy perspective) [2], encouraged by a new product and process design concept, with a gradual assessment in the supply chain. The last is to achieve an increasingly reduced impact in the management of plastic waste, with the elimination of emissions into the environment and a drastic reduction in marine litter in the first place [4].

2.2 The Work on Microplastics of the OECD Working Party on Resource Productivity and Waste (WPRPW) and of the OECD Working Party on Biodiversity, Water and Ecosystems (WBWE)

Starting from the work of the past years and that of OECD Global Forum on Environment held in 2018 and considering the growing concerns about the adverse environmental side effects of plastics related to the leakage of plastics in the natural environment, and particularly in oceans and freshwater, the two OECD Working Parties - Working Party on Resource Productivity and Waste (WPRPW) and Working Party on Biodiversity, Water and Ecosystems (WBWE) - are developing possible solutions, with a policy and technological approach, from their different perspectives, in containing and reducing microplastics pollution.

3 Discussion and Results About Works of the Two OECD WPs

Without claiming to frame the source, the fate, and the type of transport of microplastics in an exhaustive and definitive way, it is sufficient to remember that these are now a widespread problem even if they have arisen with the production of plastic materials in the last 50 years [7]. Plastic debris are now common in a ubiquitous way: they are more present in coastal areas and even more in estuarine areas. They represent damage to ecosystems because the plastic materials released into the environment imply a number of impacts on the quality of marine and coastal environments [8].

This type of pollution has been proposed as a geological indicator for the current geological era of the Anthropocene [9]. Starting from the ingestion of macro-plastics by marine wildlife, up to the global sustainability of the fishery system [10], up to the risk of human health, from the direct ingestion of plastic materials from marine foods and seafood contaminated by microplastics, the alarm is now ubiquitous and well publicized, even if there is still no conclusive scientific evidence about chemical bioaccumulation in the food chain. For this reason, microplastic pollution is the tip of the iceberg of the concern of plastics. At a global scale microplastics have been recognized as the theme to work on to mitigate the environmental impacts already acknowledged by scientific research.

Microplastics represent a great part of the total marine litter that flows into the oceans by seaside and rivers (approx 15% of mismanaged plastics waste by weight); and a substantial part of the total amount of marine litter present in the oceans, and their size implies greater ease of ingestion by all trophic levels not only of the marine environment [11], in fact there is also alarm for human ingestion of microplastics both orally (food, water) and by inhalation.

The problem of microplastics must be faced with prevention and reduction actions, up to their complete reduction, because for their removal from ecosystems there are no practical technological solutions, as is already the case for macro-plastics (optimization of waste management, clean up action, and so on). Targeted and specific removal actions can be put into action because microplastics (both primary [12] and secondary, both intentionally and unintentionally released [13]) derive from a limited number of applications in product categories which in turn have precise routes of release and transport in the environment [14]. Here below the synoptic framework of the different origins of microplastics in the sea (Table 1).

It is believed that most of the microplastics produced and microplastics resulting from product wear come from five key product categories: personal care products, plastic pellets, synthetic textiles, vehicle tyres, paints, and they find their way into the environment along a limited number of pathways; perhaps more than many words, Horton's [15] Graphical Abstract is enough for this purpose (Fig. 1).

Depending on the transport pathways described above, the mitigation approaches could be based on solutions related at source reduction, for certain way of contamination as it happens for microbeads, pellets, paintings, etc. Starting from the last few years strict prohibitions, restrictions and rules apply to use e transport such types of plastic applications (i.e. different Countries all around the world apply Microbeads Ban laws [16]).

Table 1. Synoptic framework of the different origins of microplastics in the sea

Application and primary use	Eunomia (2016) [14]	IUCN (2017) [13]
Tyres	28.4%	28.0%
Pellets	24.2%	0.3%
Textiles	20.0%	35.0%
City dust	–	24.0%
Building paint	13.7%	–
Road paint	8.4%	7.0%
Cosmetics	3.7%	2.0%
Marine paint	1.7%	3.7%

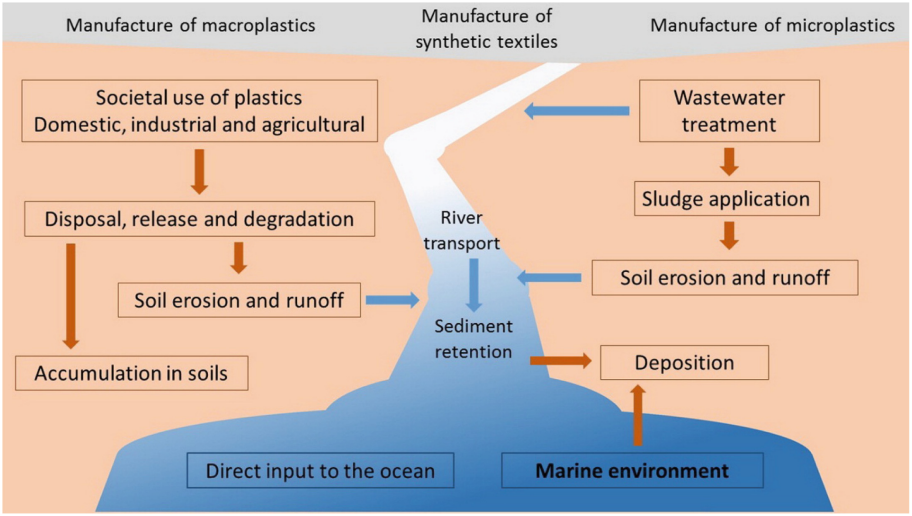

Fig. 1. Key transport pathways between terrestrial, freshwater, and marine environments. (free download from: http://dx.doi.org/10.1016/j.scitotenv.2017.01.190. With the author's permission [15])

Of course, the unintended releases still need to be resolved not only for these types of microplastics, but also those due to clothing products and those that release pieces that are mainly due to applications in fabrics of synthetic source and to the release of tyre pieces from vehicles [13].

Microplastics derived from the abrasion of vehicle tires and construction and road paints, as well as various forms of city dust are the classic example of diffuse microplastic contamination, of an unintended nature.

These types of microplastics are probably transported directly onto the ground or into the water through surface runoff during rainy events and represent the methods of depositing this contamination both on the ground and at sea [16], through the drainage water network, up to the rivers, true and proper highways to the oceans. Wind transport

can also play a role. Some studies suggests that the annual addition of microplastics to soil may be of a similar magnitude to the microplastics that make their way into the oceans [17].

4 Conclusion

Given the small size and the widespread dispersion of microplastics as can be easily understood, the option to remove them from the environment through cleaning, filtering or dredging is generally considered not feasible [8, 12, 15, 17]. Instead, the approaches that focus on reducing the flow of microplastics in the environment are recognized as the most effective [18]. At least three approaches are available:

(a) **source-reduction**: starting from minimising (micro)-plastics applications for instance: this is already happening with *the bans* [16];
(b) **waste prevention** through product design measures [18, 19], such as increased *product durability* and the adoption of *technologies to reduce* [20] the generation of *microplastics*;
(c) **end-of-pipe solutions**: that is, identifying the point at which to apply a technology to contain the release into the environment by filtering and removing the microplastics. This can be done by *upgrading wastewater treatment plants* or in the case of microfibres derived from fabrics, this could lead to *greater use of filters in washing machines*. The effectiveness and relative cost of these different approaches will vary and depend on the type, source and routes of the microplastics in the local context [15, 17].

The future work of the OECD will address these three issues, always evaluating the implications also of an economic nature, with a view to environmental and social sustainability, and using all the results and scientific evidence available to support and implement congruent local and global policies also evaluating all the sociological aspects to implement and direct them in the right direction.

Glossary

GESAMP – Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection

JRC – Joint Research Center EU Science Hub

LMICs – Lower Middle-Income Countries

NOAA – National Oceanic Atmospheric Administration

OECD – Organisation for Economic Co-operation and Development

OECD Joint Meeting – Joint Meeting of the Chemicals Committee and Working Party on Chemicals, Pesticides and Biotechnology

POPs – Persistent Organic Pollutants

SUP – Single Use Plastics

UMICs – Upper Middle-Income Countries

UNEP – Environmental Program of the United Nations

WPs – Working Parties

WPRPW – OECD Working Party on Resource Productivity and Waste

WPBWE – OECD Working Party on Biodiversity, Water and Ecosystems

References

1. OECD (2019). http://www.oecd.org/env/waste/global-forum-on-environment-plastics-in-a-circular-economy.htm. Accessed 08 July 2019
2. OECD: Considerations and criteria for sustainable plastics from a chemicals perspective. Global Forum on Environment: Plastics in a Circular Economy Designing sustainable plastics from a chemicals perspective. OECD Environment, Health and Safety Publications Series on Risk Management No. 53. Background Paper 1 (2018). http://www.oecd.org/chemicalsafety/risk-management/considerations-and-criteria-for-sustainable-plastics-from-a-chemicals-perspective.pdf. Accessed 08 July 2019
3. OECD: Technical tools and approaches in the design of sustainable plastics. Global Forum on Environment: Plastics in a Circular Economy Designing sustainable plastics from a chemicals perspective. OECD Environment, Health and Safety Publications Series on Risk Management No. 52. Background Paper 2 (2018). http://www.oecd.org/chemicalsafety/risk-management/technical-tools-and-approaches-in-the-design-of-sustainable-plastics.pdf. Accessed 08 July 2019
4. OECD: Policy approaches to incentivise sustainable plastic design. Global Forum on Environment: Plastics in a Circular Economy Designing sustainable plastics from a chemicals perspective. Prepared for OECD From Institute For European Environmental Policy (IEEP). Background Paper 3 (2018). http://www.oecd.org/environment/waste/background-paper-policy-approaches-to-incentivise-sustainable-plastic-design.pdf. Accessed 08 July 2019
5. OECD: Meeting report of the Global Forum on Environment: Plastics in a Circular Economy Designing sustainable plastics from a chemicals perspective. Environment Directorate. ENV/EPOC/WPRPW/JM(2018)1/FINAL (2018). http://www.oecd.org/chemicalsafety/risk-management/global-forum-on-environment-plastics-in-a-circular-economy-meeting-report-.pdf. Accessed 08 July 2019
6. Blair Crawford, C., Quinn, B.: Microplastic Pollutants. Elsevier Limited, London (2016)
7. Geyer, R., Jambeck, J.R., Law, K.L.: Production, use, and fate of all plastics ever made. Sci. Adv. **3**, e1700782 (2017). https://doi.org/10.1126/sciadv.1700782
8. GESAMP: Sources, fate and effects of microplastics in the marine environment: a global assessment. In: Kershaw, P.J. (ed.) IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection. Rep. Stud. GESAMP No. 90, p. 96 (2015). http://ec.europa.eu/environment/marine/good-environmental-status/descriptor-10/pdf/GESAMP_microplastics%20full%20study.pdf. Accessed 08 July 2019

9. Zalasiewicz, J., et al.: The geological cycle of plastics and their use as a stratigraphic indicator of the Anthropocene. Anthropocene **13**, 4–17 (2016). https://doi.org/10.1016/J.ANCENE.2016.01.002
10. Gall, S., Thompson, R.: The impact of debris on marine life. Mar. Pollut. Bull. **92**(1–2), 170–179 (2015). https://doi.org/10.1016/J.MARPOLBUL.2014.12.041
11. Jambeck, J., et al.: Marine pollution. Plastic waste inputs from land into the ocean. Science **347**(6223), 768–771 (2015). https://doi.org/10.1126/science.1260352. (New York, NY)
12. GESAMP: Sources, fate and effects of microplastics in the marine environment: part two of a global assessment. In: Kershaw, P.J., Rochman, C.M. (eds.) IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection. Rep. Stud. GESAMP No. 93, p. 220 (2016). http://www.gesamp.org/publications/microplastics-in-the-marine-environment-part-2. Accessed 08 July 2019
13. Boucher, J., Friot, D.: Primary Microplastics in the Oceans: A Global Evaluation of Sources, p. 43. IUCN, Gland (2017). https://portals.iucn.org/library/sites/library/files/documents/2017-002.pdf. Accessed 08 July 2019
14. Sherrington, C.: Plastics in the Marine Environment. Eunomia, Bristol (2016). http://www.eunomia.co.uk/reports-tools/plastics-in-the-marine-environment/. Accessed 08 July 2019
15. Horton, A., et al.: Microplastics in freshwater and terrestrial environments: Evaluating the current understanding to identify the knowledge gaps and future research priorities. Sci. Total Environ. **586**, 127–141 (2017). https://doi.org/10.1016/j.scitotenv.2017.01.190
16. UN Environment. Legal Limits on Single-Use Plastics and Microplastics: A Global Review of National Laws and Regulations (2018). https://wedocs.unep.org/bitstream/handle/20.500.11822/27113/plastics_limits.pdf?sequence=1&isAllowed=y. Accessed 08 July 2019
17. Microplastic in Danish wastewater Sources, occurrences and fate. Danish Environmental Protection Agency, Denmark (2017). https://www2.mst.dk/Udgiv/publications/2017/03/978-87-93529-44-1.pdf. Accessed 08 July 2019
18. WEF: The New Plastics Economy Rethinking the future of plastics. http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf. Accessed 08 July 2019
19. EC: Implementation of the Circular Economy Action Plan. Final Circular Economy Package (2017). http://ec.europa.eu/environment/circular-economy/index_en.htm. Accessed 08 July 2019
20. OECD: Improving Markets for Recycled Plastics - Trends, Prospects and Policy Responses, Organization for Economic Cooperation and Development (2018). https://dx.doi.org/10.1787/9789264301016-en. Accessed 08 July 2019